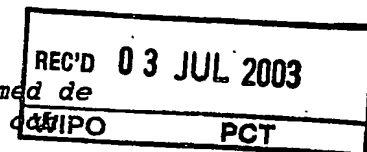


PRVPATENT- OCH REGISTRERINGSVERKET
Patentavdelningen**Intyg
Certificate**

Härmed intygas att bifogade kopior överensstämmer med de
handlingar som ursprungligen ingivits till Patent-
registreringsverket i nedannämnda ansökan.



This is to certify that the annexed is a true copy of
the documents as originally filed with the Patent- and
Registration Office in connection with the following
patent application.



(71) Sökande Nyfors Teknologi AB, Stockholm SE
Applicant (s)

(21) Patentansökningsnummer 0201946-1
Patent application number

(86) Ingivningsdatum 2002-06-25
Date of filing

Stockholm, 2003-06-17

För Patent- och registreringsverket
For the Patent- and Registration Office


Görel Gustafsson

Avgift
Fee

**PRIORITY
DOCUMENT**

SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

PATENT- OCH
REGISTRERINGSVERKET
SWEDEN

Postadress/Adress
Box 5055
S-102 42 STOCKHOLM

Telefon/Phone
+46 8 782 25 00
Vx 08-782 25 00

Telex
17978
PATOREG S

Telefax
+46 8 666 02 86
08-666 02 86

BEST AVAILABLE COPY

JON ijn

Applicant: NYFORS TEKNOLOGI AB

5

An arrangement and a method for clamping thin rods

10 TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

The present invention relates to an arrangement for clamping thin rods of glass or quartz (silica) having a diameter below 1 mm as well as a method for carrying out such a clamping according to the preambles of the appended independent arrangement and method claims.

Such an arrangement may be used to clamp and hold most varying types of rods for many different purposes, for instance an optical fibre for stripping or washing the fibre or for cleaving thereof. Although the invention is in general directed to clamping such thin rods of glass or quartz for any purpose, the invention and the problem to be solved thereby will hereinafter by way of a non-limitative example be discussed for the case of clamping optical fibres to be cleaved.

Optical fibre ends are commonly prepared for a variety of purposes (jointing, characterization etc) by a process known as cleaving. In such a process, a blade prepared from a hard material, such a diamond, is brought into a lateral engagement with the fibre to be cleaved in such a manner as to initiate a fracture which subsequently propagates through the fibre cross-section until the fibre parts. The resulting cleaved fibre end surface should, as far as possible, be optically flat and perpendicular to the fibre longitudinal axis. Undue intrusion of the blade into the

fibre during the cleaving process can damage the fibre so as to detract from the quality of the resulting end surfaces.

5 An arrangement according to the preambles of claims 1 and 2 is already known through US patent 4 790 465 disclosing an apparatus for cleaving optical fibres. Although the apparatus of US patent 4 790 465 may be used for obtaining comparatively high quality cleaved fibre end surfaces there is of course always a
10 desire to improve such an apparatus with respect to both the cleaving result and the construction and by thereby the costs for manufacture and operation thereof. The present inventors have realized that it should be possible to obtain such an improvement by modifying said first clamping means of said arrangement. The clamping member with a clamp face of substantially
15 V-groove type has to be occasionally exchanged, for example for adapting this clamping means to clamp a fibre with another diameter than the fibre cleaved in said apparatus before or for exchanging a clamping member having the V-groove worn out or damaged. This exchange takes in the apparatus according to US
20 patent 4 790 465 a considerably long period of time resulting in substantially costs as a consequence of a reduced efficiency of the apparatus. The reason for this is that a considerably amount of work is required for removing said first clamping member from the apparatus.

25 Another disadvantage of the arrangement of the apparatus according to US patent 4 790 465 is that one of the two members of the first clamping means, namely the one having said flat opposing clamp face, is pivoted with respect to the other clamping
30 member of said first clamping means for clamping an optical fibre located in the groove, and this means that there is an inherent risk of applying torsional stress to the fibre through said clamping action. Although it is stated in said US patent that the fibre is not rotated when the clamping means closes, the risk of
35 influencing the fibre in the direction of such a rotation shall not be neglected due to the presence of said pivoting movement.

Torsional stress applied to a fibre during cleaving can cause the cleave to propagate across the fibre at an angle of up to 45° with respect to the fibre axes, rather than 90° as desired.

5 SUMMARY OF THE INVENTION

An object of the present invention is to provide an arrangement of the type defined in the preamble of claim 1 having a higher efficiency discussed above than such arrangements already
10 known.

This object is according to the invention obtained by providing such an arrangement having the characteristics that the first clamping member is movably arranged with respect to a frame-
15 work of the arrangement, and that the arrangement further comprises driving means for moving the first clamping member having the grooved clamp face towards and away from the second clamping member for clamping and releasing a said rod, re-
spectively.

20 By arranging said substantially V-groove in a movable clamping member of said first clamping means and not in one being fixed to a framework of the apparatus, it will be easy to remove the first clamping member for exchanging it by another first clamp-
25 ing member having a groove being differently designed or for replacing a first clamping member being worn out or damaged by a new one. Thus, the efficiency of the arrangement may be raised.

30 Another object of the present invention is to provide an arrangement of the type defined in the preamble of appended claim 2 reducing the risks of applying torsional stress to a rod clamped by said first clamping means with respect to the ar-
35 rangement according to the US patent mentioned above.

5 This object is according to the invention obtained by providing such an arrangement having the characteristic that it further comprises driving means adapted to move at least one of said clamping members for creating a rectilinear relative movement of said clamping members towards and away from each other for clamping and releasing a said rod, respectively.

10 By arranging the members so that they will carry out a rectilinear relative movement for clamping a rod the risks of applying torsional stress to a rod being clamped will be reduced remarkably with respect to the case of arranging one of the members pivoted with respect to the other.

15 According to a preferred embodiment of the invention said clamping member being movable for clamping and releasing a said rod is received in a guide of the apparatus and removable from the apparatus by pushing and/or lifting it out of the guide for exchange. This means a remarkable improvement with respect to the apparatus of the US patent discussed above concerning the time consumption of exchange of the clamping member being provided with the groove, in the case that the first clamping member is movable, and it also means a possibility to obtain said rectilinear relative movement in a favourable way in the case that the clamping members are moved in a rectilinear relative movement for clamping a rod.

30 According to another preferred embodiment of the invention the guide is constituted by a slot having a bottom on which said clamping member is intended to rest and lateral walls intended to guide the clamping member in said movement, and the clamping member is removable from the apparatus by lifting it out of the guide. This means that this clamping member may very rapidly be removed and replaced by a new one. It is then especially preferred if the movable clamping member comprises a block-like piece resting only through gravity in said guide, and this block-like piece has preferably a considerable weight with

respect to other parts of the arrangement for reliably resting in said guide.

According to another preferred embodiment of the invention the arrangement further comprises at least one member having at least one inclined surface and means for moving said member laterally towards a rod being clamped in only a second of said two clamping locations for clamping it in the first clamping location through said first clamping means with the inclined surface into abutment against the rod for influencing the rod by sliding thereof upon said surface for reaching the position desired for said first clamping location before clamping the rod in that location. The existence of such a member moving the rod into the desired position before the rod is clamped in said first clamping location means that the clamping action may be carried out while reducing the risk of the rod being not correctly located when clamped and by this being twisted by said clamping action, which for example would degrade the quality of a future cleaved end surface as discussed above.

The arrangement also comprises an apparatus for cleaving thin rods of glass or quartz according to the appended independent apparatus claim. According to a preferred embodiment said arrangement of such an apparatus comprises a second clamping means arranged to clamp said rod in a second said clamping location, the second clamping means is movable in the longitudinal direction of a said rod extended between the two clamping locations, the apparatus comprises means for moving the second clamping means in said longitudinal direction for extending a rod clamped by said arrangement for applying a longitudinal tension load to the rod, and the second clamping means is adapted to clamp said rod in a second said clamping location belonging to the part of a cleaved rod intended for later use. This means that there is a possibility to use the power applying the tension load to move the cleaved end surface away from the cleaving point immediately when the rod parts, so that there will

be no risk of damaging this end surface by further contact with the blade after the cleaving instant. This is also the subject of another preferred embodiment of the invention. Such an embodiment is particularly advantageous in the case of having an apparatus with a body carrying the blade and driving means adapted to act upon said body for causing a relatively steady movement of the blade towards said desired cleaving point while subjecting the blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point, since this then means that there will be no risk that the vibrating blade will hit the rod once again after the rod has been cleaved.

The invention also relates to methods of clamping a thin rod according to the appended independent method claims. The advantages of such methods and the embodiments thereof according to the appended dependent method claims appear without any doubt from the above discussion of the preferred embodiments of the arrangement according to the present invention.

The invention also relates to a computer program and a computer readable medium according to the corresponding appended claims. It is easily understood that the methods according to the invention defined in the appended set of method claims are well suited to be carried out through instructions from a processor that may be influenced by a computer program provided with the program steps in question.

Further advantages as well as advantageous features of the invention appear from the following description and the other dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a specific description of a preferred embodiment of the invention cited as an example.

5 In the drawings:

10 Fig 1 is a perspective view of an apparatus according to a preferred embodiment of the invention in an initial state of a cleaving sequence of loading the apparatus with a thin rod, such as an optical fibre, to be cleaved,

15 Fig 2 is a view corresponding to fig 1 of the apparatus in a state of said cleaving sequence in which the thin rod has been clamped in two mutually-spaced clamping locations,

20 Fig 3 is a simplified side-elevation of a part of a clamping arrangement of the apparatus according to fig 1 illustrating the means for clamping the rod in one of said clamping locations and adjusting the height of the rod to be clamped there more in detail,

25 Fig 4 is a simplified side-elevation mainly illustrating a first clamping means of the apparatus according to Fig 1,

30 Fig 5 is a perspective view of the first clamping means illustrated in Fig 4 showing how easily a first clamping member thereof may be exchanged,

35 Fig 6 is a simplified view illustrating how the means for clamping said rod in the other clamping location may be moved for moving said clamping location in the longitudinal direction of the rod,

- Fig 7 is a simplified perspective view illustrating the body carrying the rod cleaving blade and the driving means used to perform the cleaving operation,
- 5 Fig 8 is a simplified perspective view of said rod cleaving blade and the body carrying the blade illustrating the principal of achieving the cleaving movements of the blade,
- 10 Fig 9 is a simplified view from above of a part of the apparatus according to fig 1 in a state of the cleaving sequence in which the vary cleaving has already been carried out, and
- 15 Fig 10 is a view corresponding to fig 9 of the step of said cleaving sequence following directly upon the state illustrated in fig 9.

20 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Fig 1 illustrates an apparatus for cleaving thin rods of glass or quartz, preferably optical fibres, having a diameter below 1 mm, and preferably in the range of 50 μm – 200 μm . The optical fibre is clamped in a second clamping means 1 in the form of a conventional fibre holder used for holding a fibre also when joining two optical fibres, and this is already known. It is schematically illustrated in fig 2 by dashed lines how a lid 2 of said clamping means may be pivoted for opening and closing this clamping means. This clamping means 1 is adapted to hold the fibre to be cleaved with a part 3 on which the cleaving is to be carried out projecting out from the fibre holder.

35 The apparatus also comprises a member 4 adapted to receive the fibre holder 1 therein for holding it in a well-defined position during the cleaving sequence. The receiving member 4 has the

character of a carriage with a bottom 5 onto which the fibre holder is intended to rest and guiding members 6 in the form of pins for laterally supporting the fibre holder in a well defined position on the carriage 4. The carriage has also a front member 7
5 extending upwardly from the bottom 5 and defining the position of the fibre holder in the longitudinal direction of a fibre held therein. This front member 7 has a central slot 8 extending therethrough and opening upwardly for receiving the free fibre part 3 therein. The carriage 4 is moveable in the longitudinal di-
10 rection of a fibre in a fibre holder received therein and in the longitudinal direction of a rail 9 in a way to be described further below.

This construction of said receiving member 4 is very favourable
15 with respect to the loading of a fibre to be cleaved in the apparatus. This loading action takes place in the following way. The fibre holder 1 with a fibre clamped therein and a part 3 to be cleaved projecting out therefrom is placed in the position shown in fig 1 with the front portions of the fibre holder 1 resting upon
20 the upper surfaces 10 of the front member 7. The guiding pins 6 will define the correct direction of the fibre holder. The fibre holder 1 is then retracted, so that it will leave the support on the front member 7 and be lowered onto the bottom 5 of the receiving member 4 while being guided in a well defined movement
25 through the guiding pins 6, and the part 3 of the fibre will move down in the slot 8 to the position shown in fig 2. This well controlled movement of the fibre part 3 means that there is no risk of damaging the fibre through contact with other members of the apparatus during this loading action.

Furthermore, the front member 7 and the bottom 5 of the carriage 4 are adapted to magnetically interact with the fibre holder 1 having for this sake magnets for keeping the fibre holder in a well defined position with the front end 11 thereof into contact
35 with the front member 7.

It is illustrated in fig 6 how the carriage is fixed to the rail 9 with a screw 50. This is done for obtaining the correct cleaving length. Means 12 for moving the rail 9 and by that the carriage 4 in the form of a dc-motor is arranged to act between a fixed frame 45 of the apparatus and an arm 52 rigidly connected to the rail 9 for moving these parts in a linear bearing 53. The connection between the motor 12 and the carriage 4 includes means 13 in the form of a load cell for measuring the load applied through the motor onto the carriage. This means when the clamping part 3 is clamped in another clamping location downstream of the fibre holder 1 that the tension in said fibre may be influenced by the motor 12 and the magnitude of that tension load may be measured by the load cell 13. The apparatus also comprises means 41 for very accurately measuring the position of the carriage 4 and communicating with a computer 40 (see below).

The apparatus also comprises a member 14 adapted to adjust the position of the fibre part 3 in another of said two clamping locations thereof before the fibre is clamped in that location. This member 14 comprises for that sake two members 15 extending substantially in parallel with each other from a frame 16 and having each two inclined surfaces 17, 18, which are oppositely inclined with respect to a horizontal plane through the two clamping locations desired. Driving means 19, here driven by compressed air, is arranged to move the member 14 so that the fibre part 3 comes into abutment against one of the inclined surfaces of each member 15 for sliding thereupon and reaching the position desired for a clamping location of the fibre part 3 corresponding to a position of the fibre part in a seat of the members 15 in the intersection between the two inclined surfaces 17, 18 of each member 15. This means that the fibre part 3 is then in a well-defined position before it is clamped, so that it may be subsequently clamped without being damaged or exerted to torsion loads or the like.

It is further illustrated in fig 3 how a spring member 20 is counter-acting the driving means 19 while being arranged to act between a member 21 being fixed with respect to a frame work 45 of the apparatus and the frame 16 of the member 14, so that the member 14 will automatically be withdrawn from the fibre part when the influence of the driving means 19 thereupon is removed.

The apparatus also comprises a first clamping means adapted to clamp the fibre in one of said two mutually-spaced clamping locations, and this first clamping means comprises a first clamping member 22 with a clamp face 23 of substantially V-groove type, for receiving a fibre part 3 in a groove 24, and a second clamping member formed by said fixed member 21 having a flat opposing clamp face 25 for retaining the fibre in the groove. The apparatus comprises a driving means 26 driven by compressed air for moving said first clamping member 22 in the direction towards the second clamping member 21 for clamping a fibre. The first clamping member 22 is constituted by a block-like piece resting only by means of the gravitation on a surface in a guide 44 having a bottom 42 and lateral walls 43 intended to guide the clamping member 22 in its rectilinear movement towards and away from the second clamping member 22, so that it may easily be removed from the apparatus by lifting it out of the guide for exchange when the groove or the face portions adjacent thereto have been worn out or for replacing it by a first clamping member being designed for clamping rods with a different diameter. Thanks to this arrangement of a preferably comparatively heavy block-like piece 22 movable in said guide a movement being perfectly rectilinear without the slightest component deviating therefrom may be achieved. It is in Fig 5 shown how easily the piece 22 may be removed and put in place. Magnets may nevertheless be used to assist to keep the piece 22 even better in place when arranged in the guide 44.

The apparatus also comprises a rod cleaving blade 27 (see especially figs 5 and 6) adapted to be brought into lateral contact with the fibre at the desired cleaving point between said two clamping locations, to achieve cleaving of the fibre at said point.

- 5 This blade 27 is made of a hard material, such as diamond. The cleaving blade is carried by a body 28 comprising a strip-like stave having the blade 27 arranged on a free end 29 thereof and being fixed at the other end 30. This stave is made of a material varying its length through application of an electric field therein,
10 i.e. a piezo-electric material.

- The apparatus further comprising driving means adapted to act upon the stave for causing a relatively steady movement of the blade towards a desired cleaving point while subjecting the
15 blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point. The arrangement of the blade on a free end of a stave means that said movements of the blade, both the relatively
20 steady movement and the relatively small-amplitude vibratory component of movement, take place along an arc-like path and the blade will hit the fibre in a direction making an angle with the fibre differing from 90° for cutting the fibre in this direction. Accordingly, this path of these movements means that the blade
25 will "scratch" the fibre when hitting it resulting in a cleaner score and fibre end surface than when just impacting the fibre perpendicularly thereto as in said US patent 4 790 465. This scratching action is further improved by arranging the blade on the free end of a projection 54 projecting from the stave towards
30 the fibre at a distance from the stave. The movements are achieved in the way illustrated in fig 6 by applying a direct voltage through a direct voltage source 31 across the stave 28, the magnitude of which is controlled by a control means 32 for bending the free end of the stave 28 towards a fibre clamped in the apparatus. The driving means also comprises an alternating
35 voltage source 33 adapted to apply an alternating voltage

across the stave 28 for generating said vibratory component of movement of the blade. Also the alternating voltage source is controlled by the control means 32. The alternating voltage applied to the stave has a frequency below 1 kHz and preferably below 750 Hz. In a particular embodiment the frequency is about 350 Hz. The peak to peak voltage of the alternating voltage may typically be in the order of 50 V, whereas the direct voltage may typically be varied from 0 to 100 V.

- 5 The stave 28 is fixed to a frame 34 moveable with respect to the frame work of the apparatus through a step motor 35 in the vertical direction in steps of for example 50 μ m for controlling the position along the blade of the blade portion used for cleaving a fibre, so that this position may be changed for changing said blade portion when a previous blade portion has been worn out, for example after carrying out about 1 000 cleaving operations while using the same blade portion therefor. This is preferably controlled by a computer program.
- 10 The rest of the constructional features of the apparatus according to the invention will now be explained while explaining the entire cleaving sequence of the apparatus:

The fibre holder 1 is firstly arranged in the carriage 4 in the way indicated in fig 1 and in the position shown in fig 2. A button is then pressed and the rest of the operation of the apparatus will take place automatically and preferably controlled by a computer 40 indicated in Fig 2. The dc-motor 12 will firstly move the carriage 4 so that the free end 36 of the fibre comes inside a small tube 37 belonging to a device 38 adapted to draw a waist fibre portion 39 away through application of negative air pressure after the cleaving has been performed. After that the driving means 19 moves the members 15 towards the fibre for entering contact therewith through the inclined surfaces 17, 18 for adjusting the height of the fibre.

The driving means 26 is then pushing the first clamping member 22 of the first clamping means towards the fixed clamping member 21 for clamping the fibre in a first clamping location mutually-spaced from the second clamping location defined by the fibre holder 1. The action of the driving means 19 upon the member 14 is then removed, so that this member 14 is retracted through the action of the spring member 20. Said computer indicated through the dashed box 40 is then sending a signal to the means 12 for influencing the carriage 4 in the longitudinal direction of the fibre away from the second clamping location for applying a tension load to the fibre. The magnitude of this tension load is measured through the load cell 13 sending information thereabout to the computer 40. The tension load is in this way set to a value by the computer, for instance 1,5 N, but this value will change with the diameter of the fibre or the rod to be cleaved.

The driving means 35 is then controlled to move the blade 27 vertically to the desired position for the cleaving procedure. The control unit 32 does then control the direct voltage source 31 to gradually increase the direct voltage applied to the stave 28 for bending the stave, so that the blade 27 carries out a relatively steady movement towards the fibre. The control unit 32 controls at the same time the alternating voltage source 33 to apply an alternating voltage to the stave 28 for causing the blade 27 to vibrate towards and away from the fibre with a small amplitude in the order of 5-40 μm , preferably in the range of 30 μm . The blade 27 will in this way move with a velocity in the order of 1 mm/s towards the fibre while oscillating for cleaving the fibre. The low frequency of the vibration means that the blade 27 will move comparatively far in the direction towards the fibre in the period of time between two subsequent oscillations at a given, suitable velocity of said relatively steady movement. When for example this velocity is 1 mm/s and said frequency is 400 Hz this means an advancing distance of 2,5 μm between subsequent "strikes" of the blade, which is much more than for the

blade in the US patent discussed in the introduction. This is a great advantage, since it means that the probability that the fibre parts already after being hit once by the blade is high and the fibre end surface resulting from the cleaving would be degraded by additional hits by the blade. The load cell 13 will indicate that the fibre has been cleaved through the disappearing of the tension load in the fibre. This information from the load cell will cause the control means 32 to stop the oscillation of the blade and remove the bending action thereupon. Furthermore the spring force in the load cell will automatically move the cleaved fibre end away from the blade immediately when the fibre parts.

The motor 12 is then controlled to move the carriage 4 slightly, in the order of 1 mm, away from the cleaving point for removing the cleaved end surface from the cleaving point as shown in fig 7. This movement will in fact be carried out automatically upon the cleaving of the fibre thanks to the favourable provision that the means 12 applying the longitudinal tension load to the fibre 3 is acting upon the carriage 4 and thereby the fibre holder 1 in the second clamping location belonging to the part of a cleaved rod intended for later use. This means that the valuable part of the fibre having the end surface aimed at by the cleaving action is efficiently immediately upon cleaving moved away from the cleaving point without any risk of being hit by the blade again after the cleaving moment. The driving means 19 is then controlled to move the member 14 to the position shown in fig 7 in contact with the waist fibre portion 39 resulting from the cleaving. The control means 32 influences then the direct voltage source 31 to move the blade 27 towards the waist fibre portion to laterally apply a force thereonto as shown in fig 7. The driving means 26 is then controlled to move the first clamping member 22 of the first clamping means away from the second clamping member 21 for releasing the waist fibre portion, and the tension caused therein by the blade will assist the waist fibre portion to

leave the groove 24 and be drawn away through the tube 37 by the device 38 for being disposed of.

5 The member 14 is retracted by shutting-off the pressurized air from the means 19, so that the spring 20 pushes the member 14 back. After that the control means 32 controls a withdrawal of the blade and the motor 35 returns the blade to the start position. The fibre holder 1 may now be removed for using the fibre end surface obtained through the cleaving process for joining or other purposes. The carriage 4 is moved to the "home" position by means of the dc-motor 12. The apparatus is now ready for cleaving a new fibre.

15 Studying the fibre end surfaces obtained by carrying out said cleaving process in the apparatus according to the present invention in interference microscope has shown that these end surfaces are of a very high quality, i.e. they are all within $\pm 0,17^\circ$ from being exactly perpendicular to the fibre longitudinal axis.

20 The invention is of course not in any way restricted to the preferred embodiment described above, but many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention as defined in the appended claims.

25 Although not necessary, it is well possible to use an anvil to support the fibre at the cleaving point.

30 The material of the body carrying the blade may just as well be of the type varying its length through application of magnetic fields, i.e. which has magneto-strictive properties, so that a relatively steady varying magnetic field and an alternating magnetic field may be used for generating the two superimposed movements of the blade according to the present invention.

35

"Relatively steady" as used for one of the movements of the blade is to be interpreted in relation to the vibratory component of movement, and does not restrict this movement to have a constant speed, but this may be changed during the movement, for example gradually decreasing or even gradually increasing. "Relatively small-amplitude" with respect to the vibratory component of movement is to be interpreted as indicating that the amplitude of this movement is small with respect to the distance the blade is moving through said relatively steady movement thereof.

It is possible to replace the members having two inclined surfaces by members having each only one inclined surface and being moved from two opposite directions towards said rod.

Although it is spoken about fibre "height" adjustment and other words defining the orientation of the apparatus are used, these are to be interpreted as not restricting the scope of the present invention, but it would for example be possible to arrange the apparatus with the fibre clamped therein extending vertically.

"Rectilinear relative movement" as used in the claims of course also covers the case of moving both said clamping members at the same time. It would also be possible to move only the second clamping member having the substantially flat clamp face. Accordingly, this clamping member may be the one received in the guide or both clamping members may be received in a guide of the type discussed above.

The arrangement may have two or all clamping means designed as said first clamping means as defined in this disclosure.

The member having at least one inclined surface for guiding the rod into said groove may just as well be arranged on the first clamping member laterally thereof for being moved together

therewith, so that the same driving means may be used for these two members.

1
2
3
4
5
6
7
8
9
10

Claims

1. An arrangement for clamping a thin rod (3) of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding a said rod extended between the two clamping locations,

said arrangement comprising first clamping means arranged to clamp said rod (3) in a first said clamping location, said first clamping means having a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove (24), and a second clamping member (21) having a substantially flat opposing clamp face for retaining the rod in the groove,

characterized in that the first clamping member is movably arranged with respect to a framework of the apparatus and that the apparatus further comprises driving means for moving the first clamping member having the grooved clamp face towards and away from the second clamping member for clamping and releasing a said rod, respectively.

2. An arrangement for clamping a thin rod (3) of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding a said rod extended between the two clamping locations,

said arrangement comprising first clamping means arranged to clamp said rod (3) in a first said clamping location, said first clamping means having a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove (24), and a second clamping member (21) having a substantially flat opposing clamp face for retaining the rod in the groove,

35

characterized in that the arrangement further comprises driving means (26) adapted to move at least one of said clamping members for creating a rectilinear relative movement of said clamping members (21, 22) towards and away from each other
5 for clamping and releasing a said rod, respectively.

3. An arrangement according to claim 1 or 2, ***characterized*** in that said clamping member (22) being movable for clamping and releasing a said rod is received in a guide (44) of the apparatus
10 and removable from the apparatus by pushing and/or lifting it out of the guide for exchange.

4. An arrangement according to claim 3, ***characterized*** in that guide is constituted by a slot (44) having a bottom (42) on which
15 said clamping member is intended to rest and lateral walls (43) intended to guide the clamping member in said movement, and that the clamping member (22) is removable from the apparatus by lifting it out of the guide.

20 5. An arrangement according to claim 3 or 4, ***characterized*** in that movable clamping member comprises a block-like piece (22) resting only through gravity in said guide.

25 6. An arrangement according to any of the preceding claims, ***characterized*** in that one (21) of said clamping members is fixed with respect to a framework (45) of the apparatus.

30 7. An arrangement according to any of the preceding claims, ***characterized*** in that it further comprises at least one member (14) having at least one inclined surface and means for moving said member laterally towards a rod being clamped in only a second of said two clamping locations before clamping it in the first clamping location through said first clamping means with the inclined surface (17, 18) into abutment against the rod for
35 influencing the rod by sliding thereof upon said surface for

reaching the position desired for said first clamping location before clamping the rod in that location.

5 8. An arrangement according to claim 7, **characterized** in that it comprises one or more said members (14) having together at least two said inclined surfaces (17, 18), which are oppositely inclined with respect to a plane including said two clamping locations and adapted to be moved by said moving means (19) laterally towards said rod for moving the rod to a seat in an intersection between said two inclined surfaces (17, 18) as seen
10 in the direction from one clamping location to the other.

9. An arrangement according to claim 7 or 8, **characterized** in that said inclined surface (17, 18) or surfaces is (are) designed
15 for adjusting the height of a said rod (3) at said first clamping location before the latter is clamped there.

10. An arrangement according to any of the preceding claims, **characterized** in that it comprises a second clamping means (1) arranged to clamp said rod in a second said clamping location, that the second clamping means is movable in the longitudinal direction of a said rod extended between the two clamping locations, that the apparatus comprises means (12) for moving the second clamping means in said longitudinal direction for extending a rod clamped by said arrangement for applying a longitudinal tension load to the rod (3).
20
25

11. An arrangement according to claim 10, **characterized** in that it further comprises means (13) for measuring said tension load and means (40) for influencing said moving means (12) for adjusting the tension load on the basis of information about the tension load from said measuring means.
30

12. An arrangement according to claim 11, **characterized** in that said adjusting means comprises a computer (40) communicating
35

with the tension load measuring means (13) for adjusting said tension load to a value that may be set by the computer.

13. An arrangement according to any of the preceding claims, **characterized** in that it is adapted to hold optical fibres.

14. An arrangement according to any of the preceding claims, **characterized** in that it is adapted to hold said rods having a diameter below 600 μm , below 300 μm and preferably between 50 and 200 μm .

15. An apparatus for cleaving thin rods (3) of glass or quartz having a diameter below 1 mm, comprising a rod cleaving blade (27), adapted to be brought into lateral contact with such a rod at a desired cleaving point between said two clamping locations, to achieve cleaving of said rod at said point, **characterized** in that it comprises an arrangement for clamping a said rod according to any of claims 1-14.

16. An apparatus according to claim 15, **characterized** in that it comprises an arrangement according to claim 10, and that the second clamping means thereof is adapted to clamp a said rod in a second said clamping location belonging to the part of the cleaved rod intended for later use.

17. An apparatus according to claim 16, **characterized** in that said means (12) for moving said clamping means (1) is adapted to automatically move the rod part clamped by said second clamping means away from the cleaving point upon cleaving of the rod as a consequence of said tension load applied there-through.

18. An apparatus according to any of claims 15-17, **characterized** in that it further comprises a body (28) carrying the blade and driving means adapted to act upon said body for causing a relatively steady movement of the blade towards said desired

cleaving point while subjecting the blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point.

5

19. An apparatus according to claim 18, *characterized* in that said body (28) is of a material varying its length through application of electric and/or magnetic fields therein, that said driving means is adapted to achieve said movements of the blade by
10 influencing said body electrically and/or magnetically for creating length variations of the material thereof, and that the driving means is adapted to make the body and by that the blade vibrate with a said relatively small-amplitude component having a frequency below 1 kHz towards and away from the cleaving
15 point for cleaving a said rod.

20. An apparatus according to claim 19, *characterized* in that said driving means is adapted to make the blade vibrate with a frequency below 750 Hz, between 100 and 700 Hz or between
20 250 and 450 Hz.

21. A method for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding the rod extended between these two clamping locations;
25

in which said clamping is in a first clamping location carried out by creating a relative movement of a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove, and a second clamping member (21) having a flat opposing clamp face (25) for retaining the rod in the groove for clamping the rod,
30

characterized in that in said clamping said first clamping member (22) having the groove is moved towards the second clamp-
35

ing member (21) being fixed with respect to a framework (45) of an apparatus for cleaving said rods for clamping a said rod.

5 22. A method for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding the rod extended between these two clamping locations;

10 in which said clamping is in a first clamping location carried out by creating a relative movement of a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove, and a second clamping member (21) having a flat opposing clamp face (25) for retaining the rod in the groove for clamping the rod,

15 *characterized* in that in said clamping at least one of said clamping members is moved for creating a rectilinear relative movement of said clamping members towards each other for clamping said rod.

20 23. A method according to claim 22, *characterized* in that said second clamping member (21) is kept fixed with respect to a framework (45) of an apparatus for cleaving thin rods while moving said first clamping member (22) having the grooved clamp face in said clamping.

25 24. A method according to any of claims 21-23, *characterized* in that it further comprises a step of adjusting the position of a rod being clamped in a second of said two clamping locations before clamping it according to said clamping step in the first
30 clamping location, in which at least one member (14) having at least one inclined surface (17, 18) is moved laterally towards said rod with the inclined surface into abutment against the rod for influencing the rod by sliding thereof upon said surface for
35 reaching a position desired for said first clamping location.

25. A method according to claim 24, *characterized* in that in said adjusting step one or more said members (14) having together at least two said inclined surfaces (17, 18), which are oppositely inclined with respect to a plane including said two clamping locations, are moved laterally towards said rod for moving the rod to a seat in an intersection between said two inclined surfaces as seen in the direction from one clamping location to the other.
26. A computer program directly loadable into the internal memory of a computer, comprising software code portions for controlling the steps of any of claims 21-25 when said program is run on the computer.
27. A computer program according to claim 26, provided at least partially through a network as the Internet.
28. A computer readable medium, having a program recorded thereon, where the program is to make a computer control the steps of any of claims 21-25.

ABSTRACT OF THE DISCLOSURE

An arrangement for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding a said rod extended between the two clamping locations. The arrangement also comprises first clamping means arranged to clamp the rod in a first clamping location. The first clamping means has a first clamping member (22) with a clamp face (23) of substantially V-groove type for receiving the rod in the groove (24). The first clamping member is movably arranged with respect to a framework (45) of the apparatus for clamping a rod.

(Fig 5).

15

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182

0301946-1

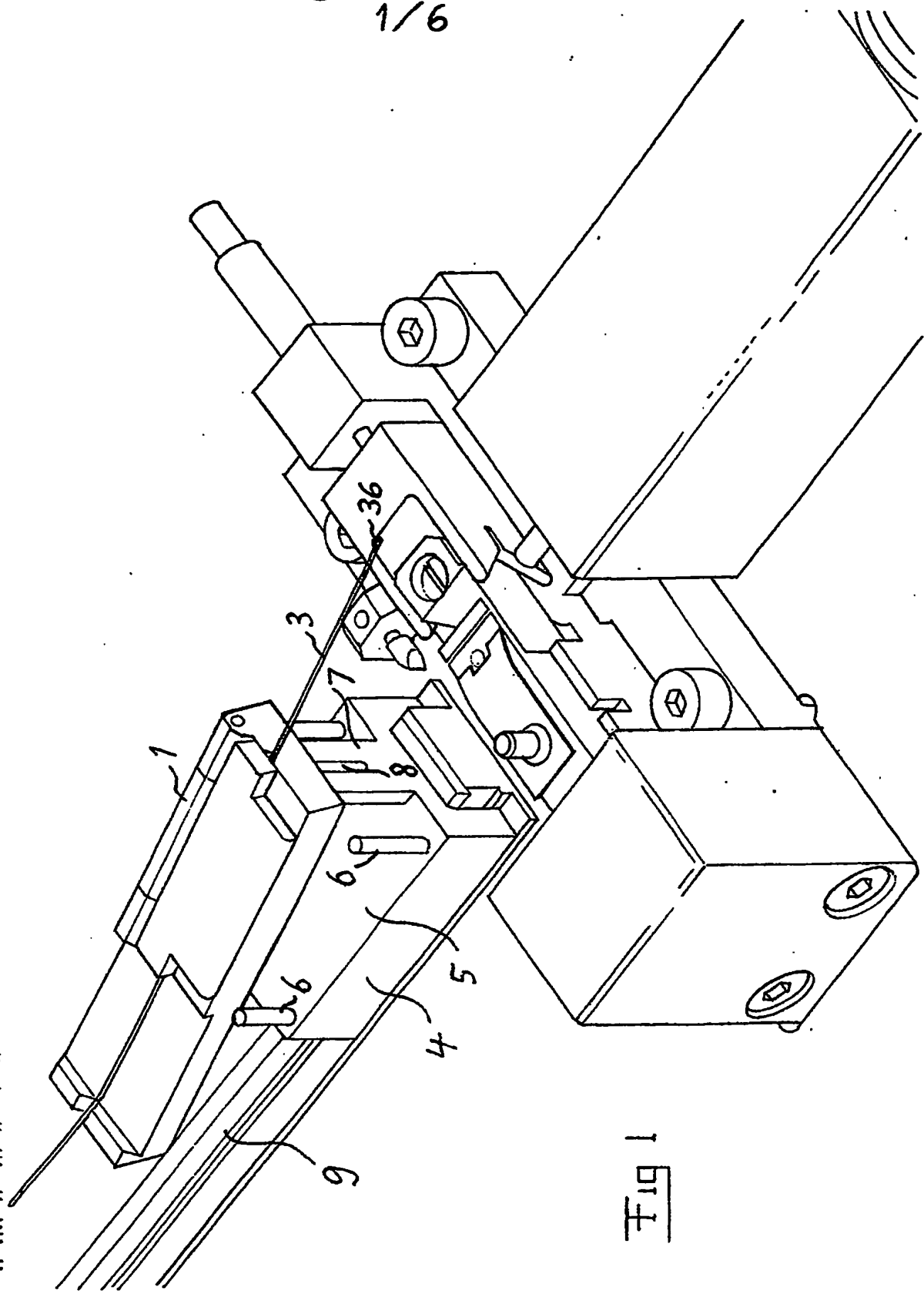


Fig 1

2 / 6

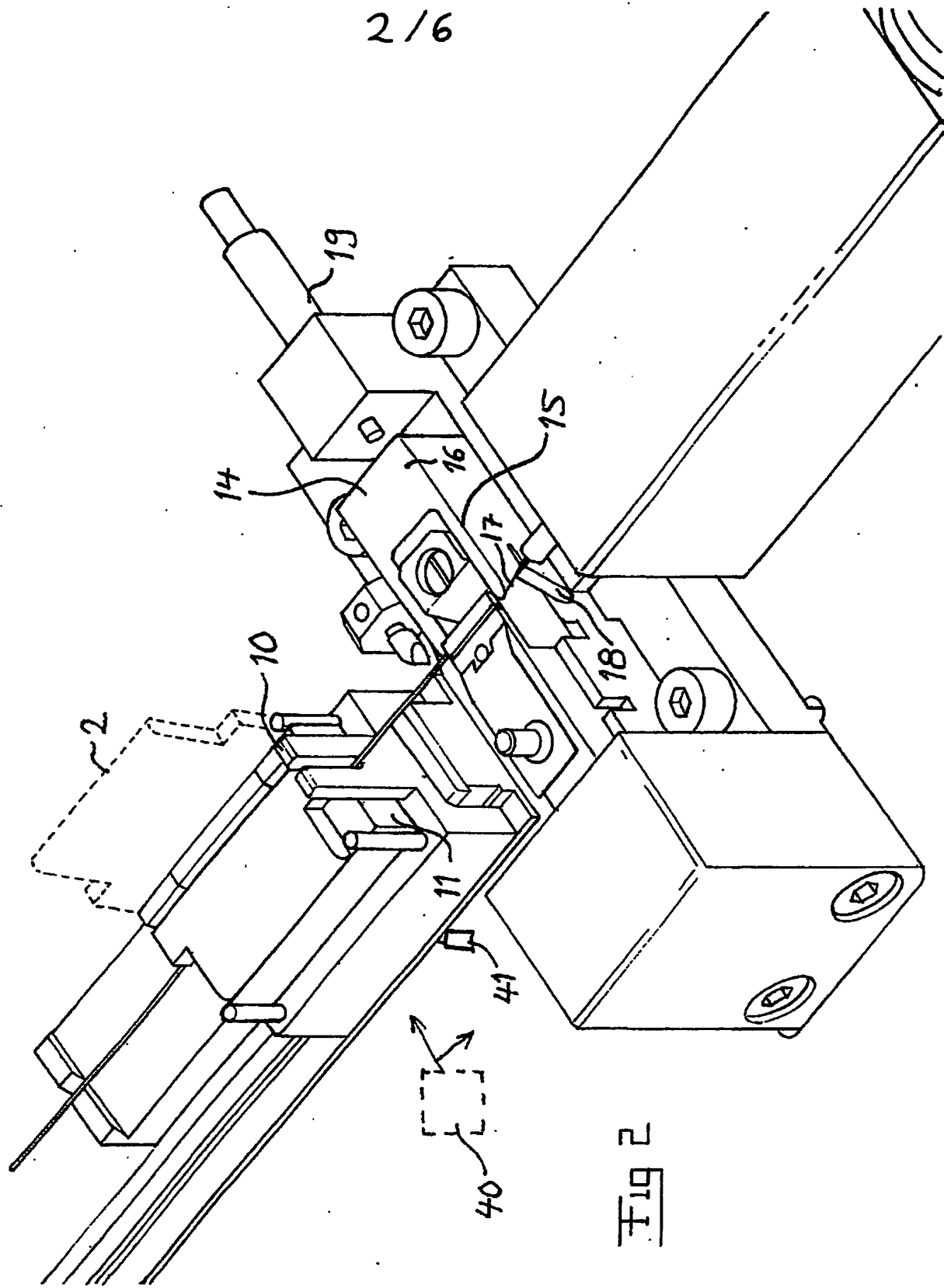


Fig 2

0301946-1

3/6

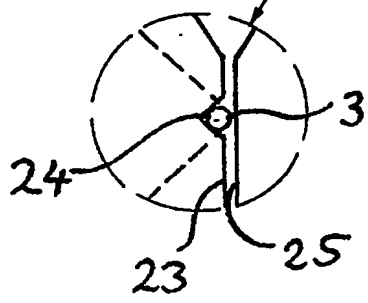
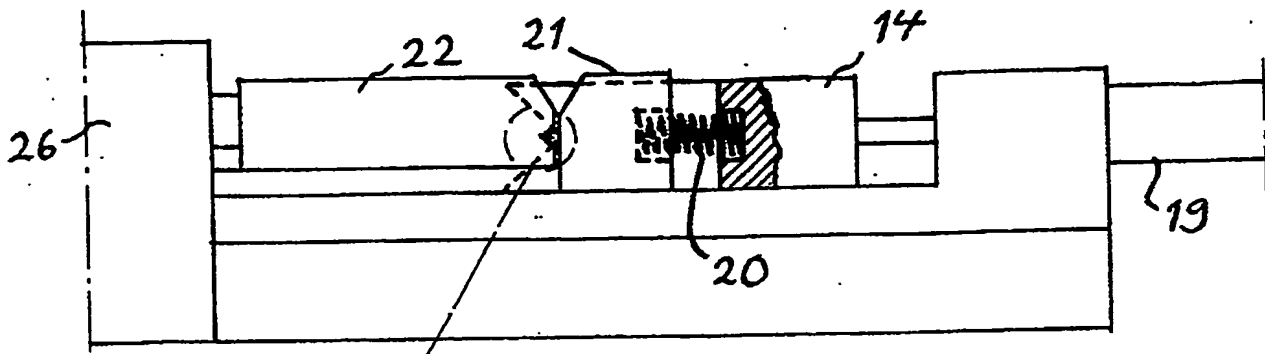


Fig 3

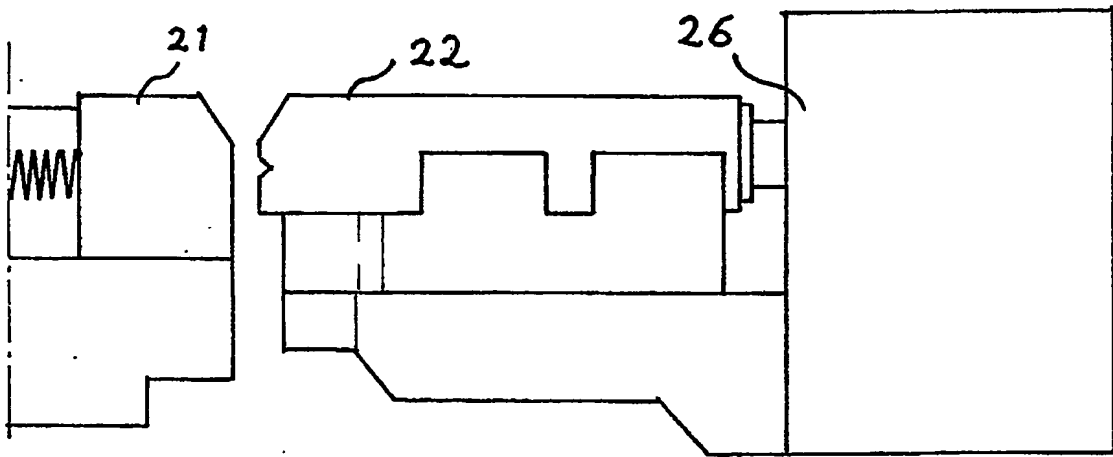


Fig 4

4/6

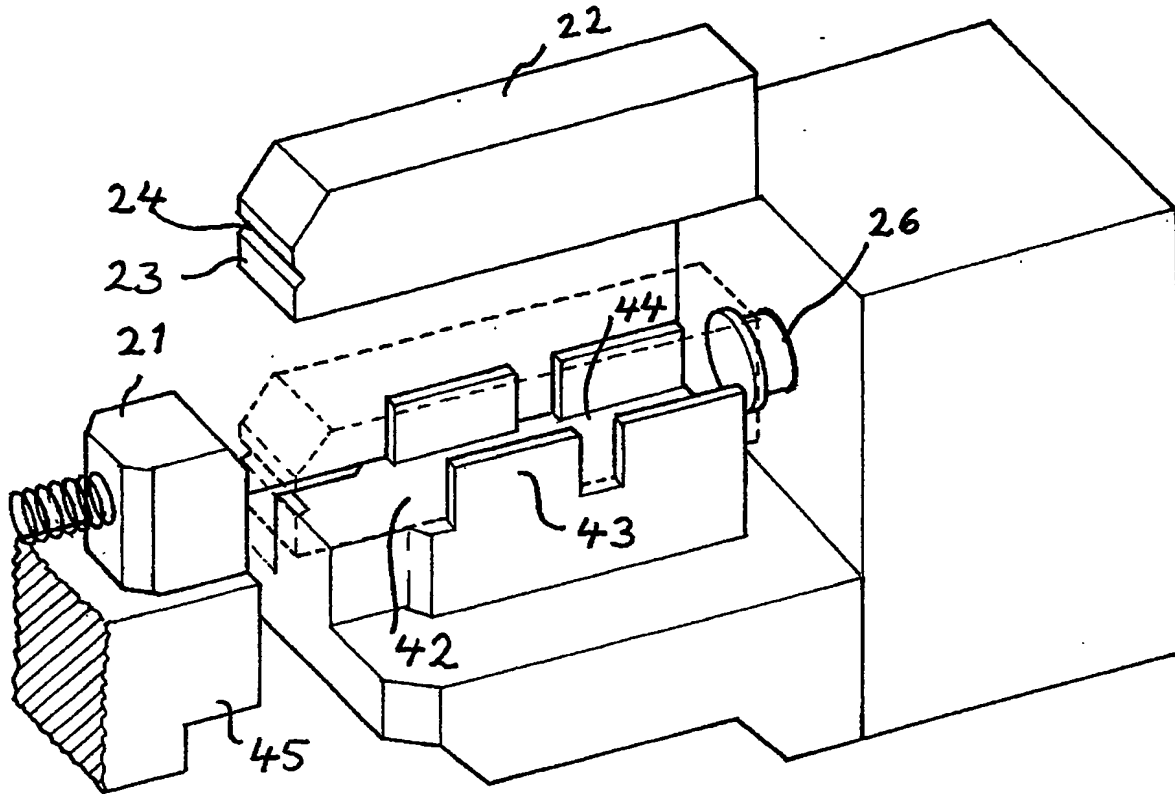


Fig 5

03060401

5/6

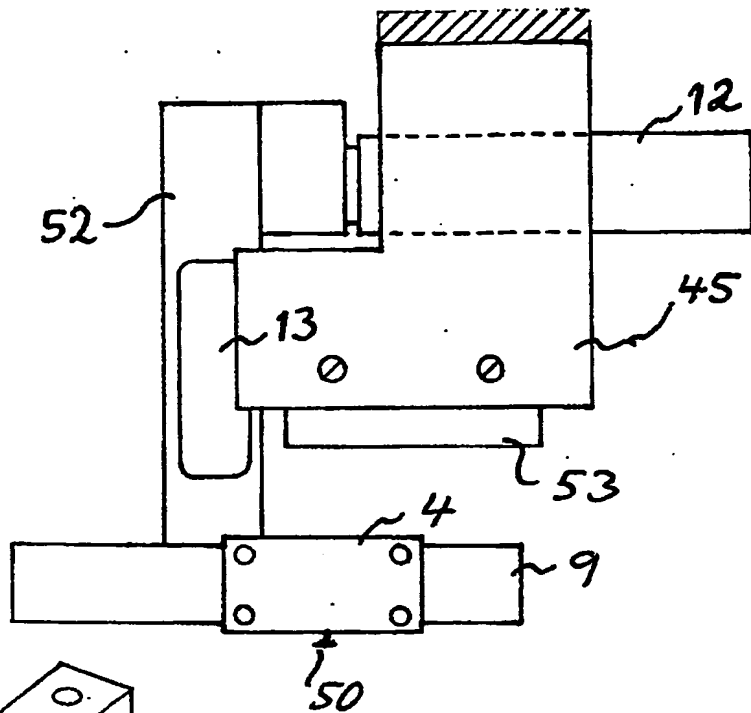


Fig 6

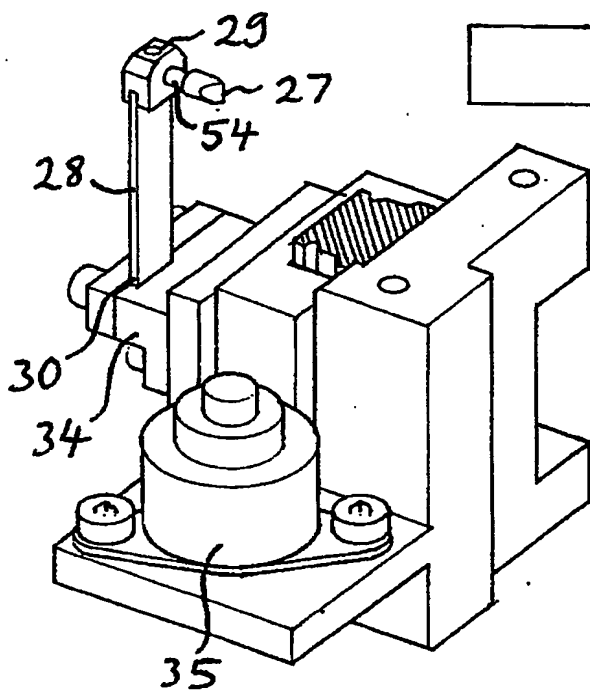


Fig 7

6/6

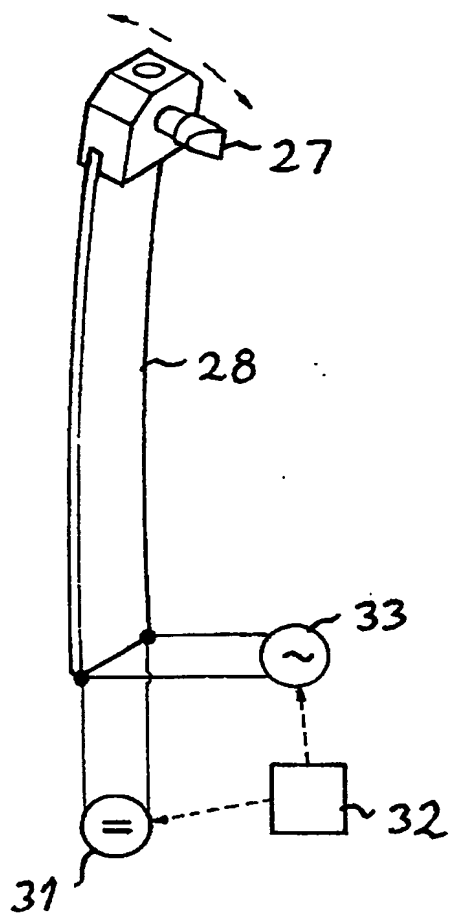


Fig 8

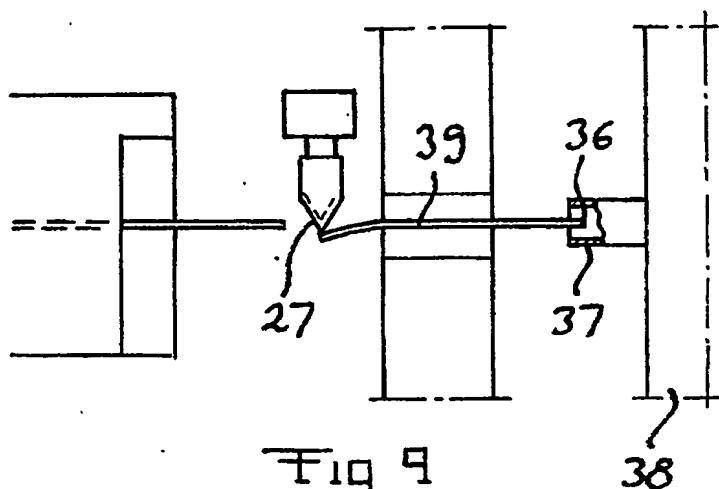


Fig 9

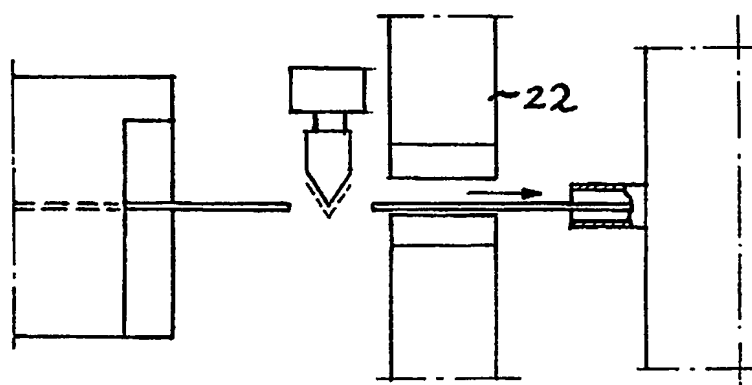


Fig 10

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☒ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☒ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.